

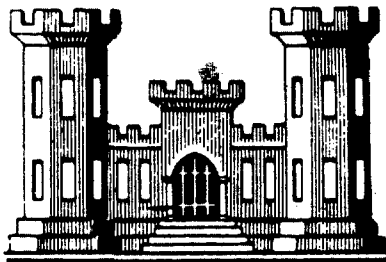
WATER RESOURCES DEVELOPMENT PROJECT

CHARLES RIVER DAM

CHARLES RIVER BASIN, MASSACHUSETTS

DESIGN MEMORANDUM NO. 3

CONCRETE MATERIALS



**DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.**

FEBRUARY 1971



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

IN REPLY REFER TO:
NEDED-E

19 February 1971

SUBJECT: Charles River Dam, Charles River Basin, Massachusetts,
Design Memorandum No. 3, Concrete Materials

Chief of Engineers
ATTN: ENGCW-E

In accordance with ER 1110-2-1150, there is submitted for review and approval Design Memorandum No. 3, Concrete Materials, for the Charles River Dam Project.

FOR THE DIVISION ENGINEER:

Incl (10 cys)
as

John Wm. Leslie
JOHN Wm. LESLIE
Chief, Engineering Division



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

IN REPLY REFER TO:
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19 February 1971

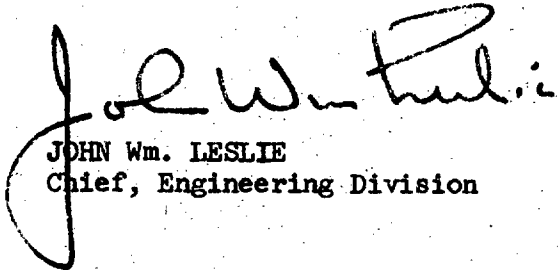
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WATER RESOURCES DEVELOPMENT PROJECT

CHARLES RIVER DAM
CHARLES RIVER BASIN
MASSACHUSETTS

Design Memorandum Index

<u>No.</u>	<u>Title</u>	<u>Scheduled Submission Date</u>	<u>Date Submitted</u>	<u>Date Approved</u>
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2	General Design, Site Geology and Relocations	Dec 1970		
3	Concrete Materials	Feb 1971	19 Feb 1971	
4	Embankments and Foundations	Apr 1971		
5	Pumping Station	May 1971		
6	Vehicular Viaduct	May 1971		
7	Navigation Locks and Facilities	Jun 1971		

CHARLES RIVER DAM
BOSTON, MASSACHUSETTS
DESIGN MEMORANDUM NO.3

CONCRETE MATERIALS

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CHARLES RIVER DAM
BOSTON, MASSACHUSETTS
DESIGN MEMORANDUM NO. 3
CONCRETE MATERIALS

1. GENERAL. The project, located in the city of Boston, Massachusetts, will require approximately 84,000 cubic yards of concrete for construction of a pumping station, locks and viaduct. The concrete will be subjected to severe climatic conditions with alternate cycles of freezing and thawing during the winter months; therefore, for durability, air-entrained concrete is considered mandatory. The pumping station and the locks above mean low water will require a superior quality concrete. The viaduct and the locks below mean low water will require a regular quality concrete. In view of the quantity of concrete involved and the location of the project, the specifications will provide for use of a semi-automatic concrete plant using stationary or truck mixers. Due to the high utilization of the land in the project area and the limited area available at the project site itself, an on-site plant is not considered feasible; therefore, an off-site plant will be specified.

2. CEMENTING MATERIALS. The size of the monoliths will not result in excessive thermal stresses but the location of the structure involves sea water sulfate exposure; therefore, Type II portland cement will be required for the project. No special investigation of portland cement was conducted as cement in this area is usually

supplied by one of six mills located in the New York Hudson River Valley or from one of the eight mills located in the Pennsylvania Lehigh Valley. All fourteen mills manufacture Type II portland cement. There are no economically available sources of natural, slag, or portland blast — furnace slag cements available in this area; therefore, these types of cement will not be specified. Investigation of commercial sources of pozzolans (fly ash) indicates no economically available sources. Costs of handling and shipping of pozzolans more than offset savings gained by its substitution for portland cement; therefore, pozzolans will not be specified.

3. AGGREGATE.

a. Field Investigation. A field reconnaissance was performed in June and November of 1970 by an engineer geologist team to determine the available sources of concrete aggregates. Due to the size and location of the project site, there is a high probability that concrete will be obtained through a ready-mix concrete supplier; therefore, the available source investigation includes not only the potential aggregate sources in the project area but also those sources which normally supply the ready mix companies located in the project area. There are six potential sources of processed sand and gravel and three potential sources of processed crushed stone. Table II lists the sources and locations, plant capacity, and haul distance to the project site of each source of aggregate checked during the field reconnaissance.

TABLE II

<u>AGGREGATE Source and Location</u>	<u>Plant Capacity (tons per hour)</u>	<u>Haul Distance (Miles)</u>
Rowe Contracting Co., (1) Malden, Mass.	300	6
Old Colony Crushed Stone Co.(1) Quincy, Mass.	400	11
Lynn Sand & Stone Co., (1) Swampscott, Mass.	450	13
Burlington Sand & Stone Co. Burlington, Mass.	200	15
A. A. Will Sand & Gravel Corp. Canton, Mass.	400	17
M. Benevento Sand & Gravel Co. Wilmington, Mass.	450	17
Glenview Sand & Gravel Co. Chelmsford, Mass.	300	26 (2)
Plainville Sand & Stone, Inc. Plainville, Mass.	500	30
Ossipee Aggregate Corp. Ossipee, N. H.	400	100 (2)

(1) Produce only crushed stone

(2) Rail haul

The locations of the project site and the commercial sources of aggregate are shown on Plate 3-1. M. Benevento Sand and Gravel Company produces fine and coarse aggregate used in portland cement and bituminous concrete. Burlington Sand and Stone Company regularly use their fine and coarse aggregate in portland cement concrete. A. A. Will Sand and Gravel Company do not regularly use their coarse and fine aggregate in the production of portland cement concrete.

The aggregates produced by the plants of Lynn Sand and Stone Company (Coarse Aggregate), Plainville Sand and Stone Incorporated, (Coarse and Fine Aggregate), Ossipee Aggregate Corporation (Coarse and Fine Aggregate), and Glenview Sand and Gravel Corporation (Fine Aggregate) were selected for evaluation testing. These sources regularly supply the ready mix suppliers in the project area and are considered as having the best potential for supplying concrete aggregate for the project. Rowe Contracting Company and Old Colony Crushed Stone Company have been tested previously and current samples indicate that the materials are now identical to those previously tested. Photographs of working faces of Rowe Contracting Company, Old Colony Crushed Stone Company and Lynn Sand and Stone Company are shown on Plates 3-2 thru 3-4 respectively. The maximum size aggregates readily commercially available in this area are 1-1/2 inches, and based on increased costs of production for larger sizes and elimination of some aggregate sources, it is concluded that no economical advantage would be obtained by requiring a larger maximum size aggregate.

b. Tested Sources and Estimated Prices. The sources of aggregate tested and the estimated delivered prices to the project site of these aggregates, based on the quoted plant prices and Massachusetts Department of Public Utilities minimum trucking rates, which are currently twenty-five cents per ton for the first mile and five cents per ton for each additional mile are as follows:

(1) Rowe Contracting Company. Quoted plant prices are \$2.00 to \$3.50 per ton for crushed stone depending on the size group. The delivered price to the site will average \$2.60 per ton for crushed stone.

(2) Old Colony Crushed Stone Company. Quoted plant prices are \$2.40 to \$3.75 per ton for crushed stone, depending on the size group. The delivered price to the site will average \$3.21 per ton for crushed stone.

(3) Lynn Sand and Stone Company. Quoted plant prices are \$1.90 to \$3.35 per ton for crushed stone, depending on the size group. The delivered price to the site will average \$2.89 per ton for crushed stone.

(4) Glenview Sand and Gravel Company. Quoted plant prices are \$2.50 to \$3.75 per ton for gravel, depending on the size group and \$1.65 per ton for concrete sand. The delivered prices, by rail, will average \$4.25 per ton for gravel and \$2.90 per ton for concrete sand. Only the fine aggregate from this source has been evaluated by testing.

(5) Plainville Sand and Stone, Incorporated. Quoted plant prices are \$2.00 to \$2.30 per ton for gravel, depending on the size group and \$1.60 per ton for concrete sand. The delivered prices to the site will average \$3.76 per ton for gravel and \$3.30 per ton for concrete sand.

c. Aggregate Tests. Results of aggregate tests performed on materials from the four sources which have undergone evaluation testing for this project are summarized on Plate Numbers 3-5 through 3-8.

A petrographic examination of coarse aggregates from Rowe Contracting Company and Old Colony Crushed Stone Company indicated that the materials are now identical to those previously tested. Results of aggregate tests for these two previously tested sources are summarized respectively on Plate Numbers 3-9 and 3-10.

Results of the weathering tests show that the DFE (durability factor) of the tested sources range from a high of 87 to a low of 57. The DFE value of 57 represents a quality rating of good, but due to its relatively poor rating in comparison to the other sources tested, a DFE of 57 will be set as the lowest limit acceptable for aggregate to be used on this project.

d. Concrete Making Properties of Aggregates. The water cement ratio and cement factor versus compressive strength curves developed by utilizing concrete aggregates for the sources tested are shown on Plate Numbers 3-11 through 3-14 for all sources except Old Colony Crushed Stone Company and Glenview Sand and Gravel Company for which test data are not available.

e. Service Records. The aggregates from the tested sources have been used in concrete for a number of federal, state

and local projects. Rowe Contracting Company has regularly supplied coarse aggregates for construction of state and private buildings in the Boston Area. Old Colony Crushed Stone Company regularly supplies coarse aggregate to Crazziano Transit-Mixed Company in Braintree, Massachusetts for local building construction. Lynn Sand and Stone Company supplies coarse aggregate used in state and private buildings, state highway bridges and military construction. Glenview Sand and Gravel Company supplies fine aggregate to Allied Concrete Company in Everett, Massachusetts and fine and coarse aggregate to E. A. Wilson Concrete Company, Andover, Massachusetts. Glenview Company aggregate has been used in many state buildings and on state highways. Plainville Sand and Stone, Incorporated fine and coarse aggregates have been used in state and federal structures. Ossipee Aggregate Corporation fine and coarse aggregates have been used in state and local structures. The performance of aggregates from all of the sources is considered satisfactory, although it must be noted the period of record is less than fifteen years.

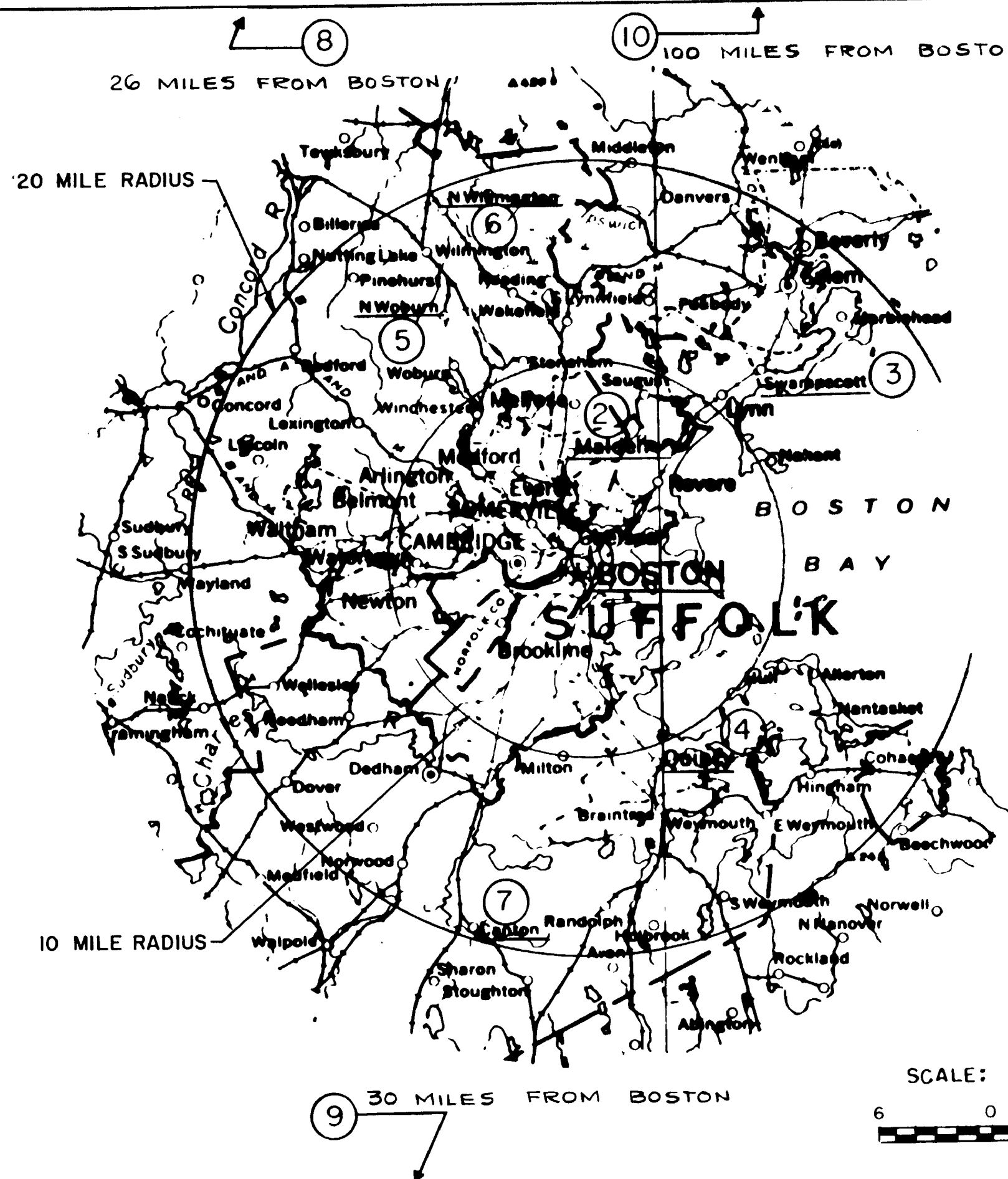
4. WATER. The concrete structures will be constructed in or adjacent to sea water. The use of sea water will not be considered for mixing or curing concrete. It is assumed that water for both mixing and curing will be obtained from a city water supply and since the exact sources could not be predetermined, tests were not performed. Sources of water proposed by the contractor for mixing and curing concrete will be tested prior to use. The water which will be impounded by the concrete structure has been tested to determine

whether it contains any concentration of deleterious chemicals which might affect the proportioning of concrete or the selection of cement type. The results of laboratory tests performed on the water sample indicate the water is essentially diluted sea water.

5. SOURCES OF CONCRETE. There are three sources of ready-mixed concrete within a six mile haul distance of the project site. Boston Sand and Gravel Company operates an automatic central-mix type concrete plant in Charlestown, Massachusetts approximately a one mile haul distance to the site. This plant is supplied with fine and coarse aggregates which are shipped, by rail, from Ossipee Aggregate Corporation, Ossipee, New Hampshire. Allied Concrete Corporation operates a semi-automatic central-mix type concrete plant in Everett, Massachusetts, approximately a three mile haul distance to the site. This plant is supplied, by rail, with fine aggregate from Glenview Sand and Gravel Company, Chelmsford, Massachusetts and coarse aggregate, by truck, from Lynn Sand and Stone Company, Swampscott, Massachusetts. J. H. McNamara, Incorporated, operates an automatic transit-mix type concrete plant in Allston, Massachusetts, approximately a five mile haul distance to the site. This plant is supplied, by truck, with fine and coarse aggregates from Plainville Sand and Stone, Incorporated, Plainville, Massachusetts.

6. RECOMMENDATIONS AND CONCLUSIONS. Based on data presented herein, it is considered that aggregate from any of the six sources tested is acceptable and it is recommended that fine aggregate from

the three tested sources and coarse aggregate from the five tested sources, as listed, be approved.



- ① CHARLES RIVER DAM
- ② ROWE CONTRACTING COMPANY
- ③ LYNN SAND AND STONE COMPANY
- ④ OLD COLONY CRUSHED STONE COMPANY
- ⑤ BURLINGTON SAND AND STONE COMPANY
- ⑥ M. BENEVENTO SAND AND GRAVEL CO.
- ⑦ A. A. WILL SAND AND GRAVEL CORPORATION
- ⑧ GLENVIEW SAND AND GRAVEL COMPANY
- ⑨ PLAINVILLE SAND AND STONE INCORPORATED
- ⑩ OSSIPPEE AGGREGATES CORPORATION

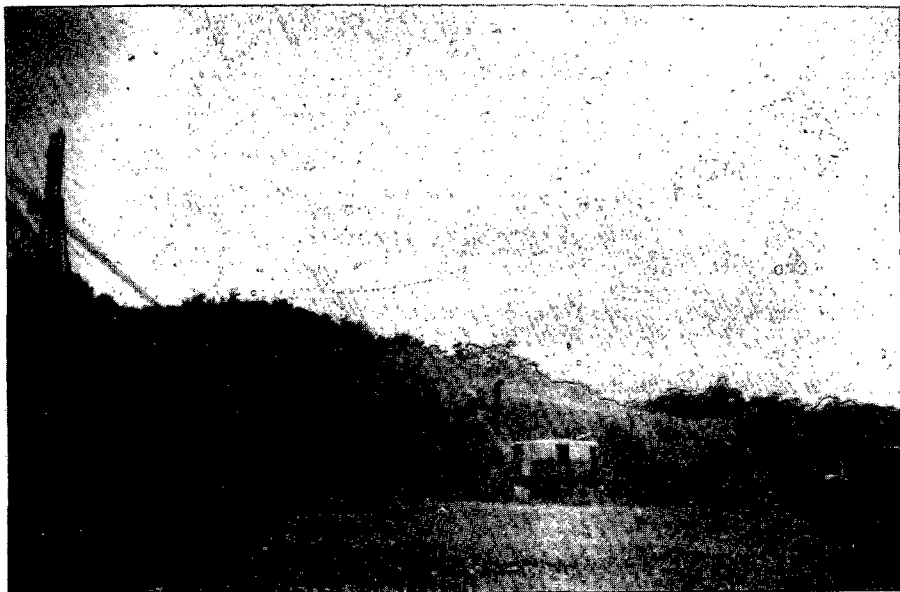
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

CHARLES RIVER DAM
CHARLES RIVER
LOCATION OF COMMERCIAL
CONCRETE AGGREGATE SOURCES

BOSTON MASSACHUSETTS



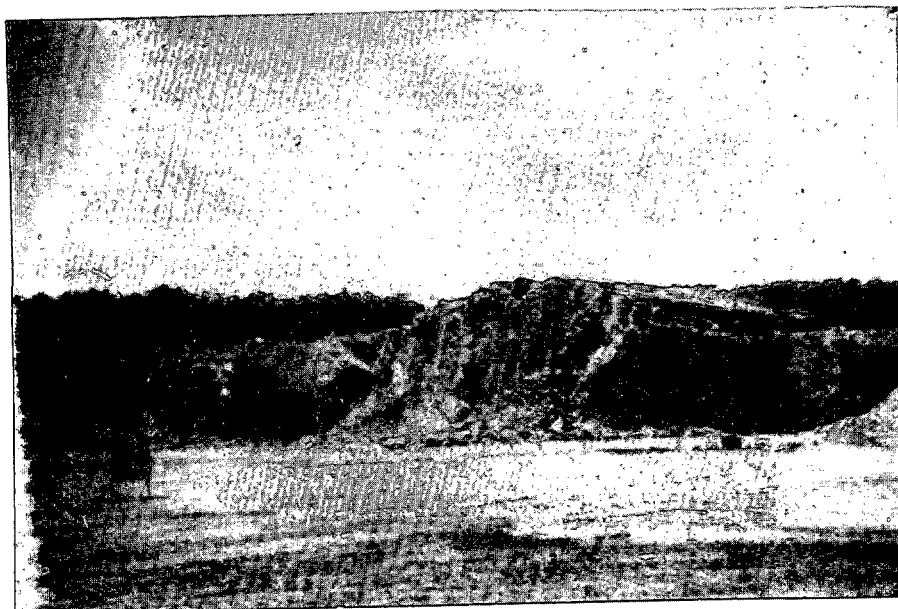
Rowe Contracting Company
Malden, Massachusetts
Quarry Face 2000 feet long



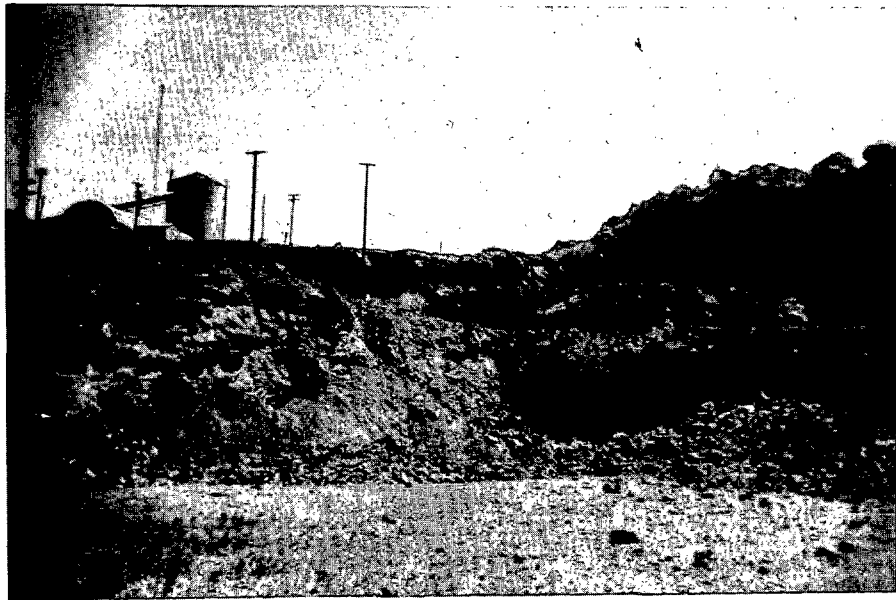
Rowe Contracting Company
Malden, Massachusetts
Quarry Face 100 feet high



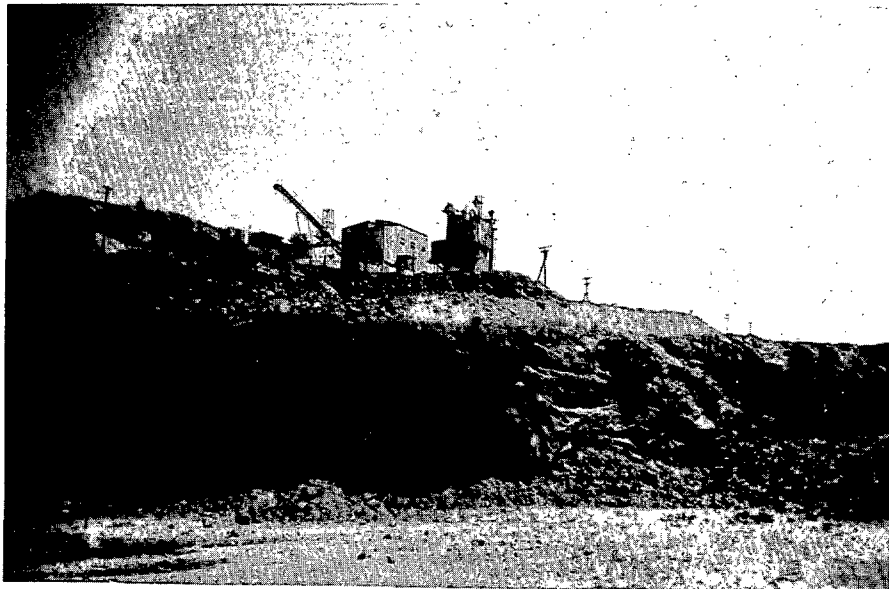
Old Colony Crushed Stone Company
Quincy, Massachusetts
Quarry Face 2000 feet long



Old Colony Crushed Stone Company
Quincy, Massachusetts
Quarry Face 150 feet high



Lynn Sand and Stone Company
Swampscott, Massachusetts
Quarry Face 2000 feet long



Lynn Sand and Stone Company
Swampscott, Massachusetts
Quarry Face 120 feet high

STATE: <u>Mass.</u>		INDEX NO.:		AGGREGATE DATA SHEET		TESTED BY: <u>NED Laboratory</u>	
LAT.: <u>42°N</u>		LONG.: <u>70°W</u>		DATE: <u>September 1970</u>			
LAB. SYMBOL NO.: <u>82-1-1 thru 3</u>				TYPE OF MATERIAL:			
LOCATION: <u>30 Danvers Road</u>							
<u>Swampscott, Mass.</u>							
PRODUCER: <u>Lynn Sand and Stone Company</u>							
SAMPLED BY: <u>NED, A. Carosella</u>							
TESTED FOR: <u>Charles River Dam</u>							
USED AT: <u>Military Construction</u>							
<u>Boston Army Base, S. Boston, Mass. (1954-56)</u>							
PROCESSING BEFORE TESTING: <u>Crushing and Sizing by Producer</u>							
GEOLOGICAL FORMATION AND AGE:							

GRADING (CRD-C 103) (Cum. % Passing)						TEST RESULTS				FINE AGG.																											
SIZE	2"	1"	3/4"	1/2"	3/8"					3/4	1/2	3/8																									
SIEVE						BULK SP. GR., SAT SURF DRY (CRD-C 107, 108):				2.922	2.892	2.90																									
6 IN.						ABSORPTION, PER CENT (CRD-C 107, 108):				0.800	0.901	0.07																									
5 IN.						ORGANIC IMPURITIES, FIG. NO. (CRD-C 121):																															
4 IN.						SOFT PARTICLES, PER CENT (CRD-C 130):																															
3 IN.						PER CENT LIGHTER THAN SP. GR. (CRD-C 129):																															
2 1/2 IN.	100					PER CENT FLAT AND ELONGATED (CRD-C 119, 120):				6.1																											
2 IN.	97					WEIGHTED AV. % LOSS, 5 CYC. MgSO ₄ (CRD-C 115)																															
1 1/2 IN.	16	100				ABRASION LOSS (L.A.), % (CRD-C 117):																															
1 IN.	4	74	100			UNIT WT., LB/CU FT (CRD-C 106):				103	102	99.2																									
3/4 IN.	1	34	92	100		CLAY LUMPS, % (CRD-C 118):																															
1/2 IN.		3	30	98	100																																
3/8 IN.		1	6	16	99	SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124):																															
NO. 4			3	6	12	REACTIVITY WITH NaOH (CRD-C 126):				S _c , mm/L:																											
NO. 8			2	1	5					R _c , mm/L:																											
NO. 16			2	3	3	MORTAR-MAKING PROPERTIES (CRD-C 118)																															
NO. 30			2	3	2																																
NO. 50			2	2	2	TYPE _____ CEMENT, RATIO _____ DAYS, _____ % _____ DAYS, _____ %																															
NO. 100			1.6	1.7	1.6	LINEAR THERMAL EXPANSION X 10 ⁻⁶ /DEG. F. (CRD-C 125, 126): <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th>ROCK TYPE</th> <th>PARALLEL</th> <th>ACROSS</th> <th>ON</th> <th>AVERAGE</th> </tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </table>							ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE																				
ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE																																	
NO. 200			1.2	1.3	1.2																																
- 200 ^(a)			0.6	0.7	1.4																																
F.M. ^(b)			6.88	6.35	5.44																																

(a) CRD-C 105 (b) CRD-C 104

MORTAR:

MORTAR-BAR EXPANSION AT 100F, % (CRD-C 123):				FINE AGGREGATE				COARSE AGGREGATE			
	3 MO.	6 MO.	9 MO.	12 MO.	3 MO.	6 MO.	9 MO.	12 MO.			
LOW-ALK. CEMENT: % Na ₂ O EQUIVALENT:											
HIGH-ALK. CEMENT: % Na ₂ O EQUIVALENT:											

SOUNDNESS IN CONCRETE (CRD-C 40, 114):

FINE AGG.	COARSE AGG.	F & T	HW-CD	HD-CW
Glenview Sand & Gravel Co., Chelmsford, Mass.	Lynn Sand & Stone	DFE 900		
		DFE 700	57	

PETROGRAPHIC DATA (CRD-C 127): SUMMARY: The crushed quarry stone is comprised of aphanitic to medium grained igneous rocks ranging from diorite to granite. Physically, the material is of angular particle shape, smooth to rough textured with weathering primarily confined to the granitic rock varieties. The rock particles are primarily hard, dense and unweathered with only 3% showing a slight degree of surface weathering. The particle constituents, based on the theoretical maximum density blend, approximates the following percentages: 66% Diorite, 13% Granodiorite, 15% Dark Aphanitic Varieties, 6% Granitic. This material is considered to be of good quality for use as a concrete aggregate.

REMARKS:

STATE: <u>Mass.</u>		INDEX NO.:		AGGREGATE DATA SHEET		TESTED BY: <u>NED Laboratory</u>	
LAT: <u>42°N</u>		LONG: <u>71°W</u>		DATE: <u>September 1970</u>			
LAB. SYMBOL NO.: <u>82-1-1 thru 3</u>				TYPE OF MATERIAL: <u>Proc. Sand & Gravel</u>			
LOCATION: <u>Madison Street, Plainville, Mass.</u>							
PRODUCER: <u>Plainville Sand and Stone Inc.</u>							
SAMPLED BY: <u>NED, A. Carosella</u>							
TESTED FOR: <u>Charles River Dam</u>							
USED AT:							
PROCESSING BEFORE TESTING: <u>Crushing, Sizing and Washing by Producer</u>							
GEOLOGICAL FORMATION AND AGE: <u>Pleistocene Terrace</u>							

GRADING (CRD-C 103)(Cum. % Passing):				TEST RESULTS																												
SIZE			FINE AGG.				FINE AGG.																									
SIEVE <u>1 1/2"</u>		<u>3/4"</u>		BULK SP. GR., SAT SURF DRY (CRD-C 107, 108):	<u>2.67</u>	<u>2.66</u>	<u>2.63</u>																									
6 IN.				Absorption, PER CENT (CRD-C 107, 108):	<u>0.96</u>	<u>1.23</u>	<u>1.32</u>																									
5 IN.				ORGANIC IMPURITIES, FIG. NO. (CRD-C 121):			<u>1</u>																									
4 IN.				SOFT PARTICLES, PER CENT (CRD-C 130):																												
3 IN.				PER CENT LIGHTER THAN SP. GR. (CRD-C 129):																												
2 1/2 IN.				PER CENT FLAT AND ELONGATED (CRD-C 119, 120):	<u>2.0</u>																											
2 IN.	<u>100</u>			WEIGHTED AV. % LOSS, 5 CYC. $MgSO_4$ (CRD-C 115):		<u>7.2</u>	<u>2.5</u>																									
1 1/2 IN.	<u>99</u>			ABRASION LOSS (L.A.), % (CRD-C 117):		<u>27.4</u>																										
1 IN.	<u>55</u>	<u>100</u>		UNIT WT., LB/CU FT (CRD-C 106):	<u>100.0</u>	<u>102.2</u>	<u>111.8</u>																									
3/4 IN.	<u>10</u>	<u>99</u>		CLAY LUMPS, % (CRD-C 118):																												
1/2 IN.	<u>2</u>	<u>47</u>																														
3/8 IN.	<u>1</u>	<u>23</u>		SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124):																												
NO. 4	<u>1</u>	<u>8</u>	<u>100</u>	REACTIVITY WITH NaOH (CRD-C 128):	<u>3c, mm/L:</u>																											
NO. 8	<u>1</u>	<u>4</u>	<u>87</u>		<u>Rc, mm/L:</u>																											
NO. 16	<u>1</u>	<u>3</u>	<u>67</u>	MORTAR-MAKING PROPERTIES (CRD-C 116)																												
NO. 30	<u>1</u>	<u>2</u>	<u>15</u>	TYPE <u>II</u> CEMENT, RATIO <u>7</u> DAYS, <u>115</u> %, <u>28</u> DAYS, <u>112</u> %																												
NO. 50	<u>1</u>	<u>2</u>	<u>24</u>	LINEAR THERMAL EXPANSION $\times 10^{-5}$ DEG. F. (CRD-C 125, 126):																												
NO. 100	<u>0.6</u>	<u>1.2</u>	<u>7</u>	<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th>ROCK TYPE</th> <th>PARALLEL</th> <th>ACROSS</th> <th>ON</th> <th>AVERAGE</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table>				ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE																				
ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE																												
NO. 200	<u>0.4</u>	<u>0.8</u>	<u>1.7</u>																													
- 200 ^{us}	<u>0.2</u>	<u>0.8</u>	<u>1.8</u>																													
F.M. ^(b)	<u>7.58</u>	<u>6.59</u>	<u>2.7</u>																													

(a) CRD-C 105 (b) CRD-C 104

MORTAR:

MORTAR - BAR EXPANSION AT 100°F, % (CRD-C 123):				FINE AGGREGATE				COARSE AGGREGATE				
	3 MO.	6 MO.	9 MO.	12 MO.	3 MO.	6 MO.	9 MO.	12 MO.	3 MO.	6 MO.	9 MO.	12 MO.
LOW-ALK. CEMENT: % Na_2O EQUIVALENT:												
HIGH-ALK. CEMENT: % Na_2O EQUIVALENT:												
SOUNDNESS IN CONCRETE (CRD-C 40, 114):									F & T	HW - CD	HD - CW	
FINE AGG. <u>Plainville Sand & Stone, Inc.</u>									COARSE AGG. <u>Plainville Sand & Stone, Inc.</u>			
FINE AGG. <u>Stone, Inc.</u>									COARSE AGG. <u>Inc.</u>			

PETROGRAPHIC DATA (CRD-C 127): SUMMARY: 1. Gravel. The particle constituents of the gravel fraction based on the theoretical maximum density blend approximates the following percentages: 51% Granite, 26% Quartzite, 14% Dark Basic Rock Types, 4% Shale and Schist, 4% Siltstone and Conglomerate, 1% Feldspar. Angular to subrounded, pink to dark gray, sound aggregates comprised of 53% slightly weathered, 43% unweathered and 4% weathered particles. The slightly weathered fraction is generally only surface weathered providing a sound and hard material. Weathered material is considered soft and unsound. Weathering is primarily confined to the granite, siltstone and conglomerate fractions.

REMARKS: Other than a heavier than normal dust coating which is easily removed by washing, this material is considered to be of satisfactory quality for the intended use.

STATE: Mass.		INDEX NO.:		AGGREGATE DATA SHEET		TESTED BY: NED Laboratory	
LAT: 42°N		LONG: 71°W		DATE: September 1970			
LAB. SYMBOL NO.: 82-2-1				TYPE OF MATERIAL: Proc. Natural Sand			
LOCATION: Stemdon Street							
Chelmsford, Mass.							
PRODUCER: Glenview Sand and Gravel Company							
SAMPLED BY: NED, A. Carosella							
TESTED FOR: Charles River Dam							
USED AT:							
PROCESSING BEFORE TESTING: Crushing, Sizing and Washing by Producer							
GEOLOGICAL FORMATION AND AGE: Glacial Outwash-Pleistocene							

GRADING (CRD-C 103)(CUM. % PASSING):					TEST RESULTS					FINE AGG.																									
SIZE				FINE AGG.																															
SIEVE					BULK SP. GR., SAT SURF DRY (CRD-C 107,108):					2.61																									
6 IN.					ABSORPTION, PER CENT (CRD-C 107,108):					1.77																									
5 IN.					ORGANIC IMPURITIES, FIG. NO. (CRD-C 121):					1																									
4 IN.					SOFT PARTICLES, PER CENT (CRD-C 130):					—																									
3 IN.					PER CENT LIGHTER THAN SP. GR. (CRD-C 129):					—																									
2 1/2 IN.					PER CENT FLAT AND ELONGATED (CRD-C 119,120):					—																									
2 IN.					WEIGHTED AV. % LOSS, 5 CYC. MgSO ₄ (CRD-C 115):					9.5																									
1 1/2 IN.					ABRASION LOSS (L. A.), %, (CRD-C 117):					—																									
1 IN.					UNIT WT., LB/CU FT (CRD-C 106):					107.4																									
3/4 IN.					CLAY LUMPS, % (CRD-C 118):					—																									
1/2 IN.					SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124):					—																									
3/8 IN.										—																									
NO. 4				100	REACTIVITY WITH NaOH (CRD-C 128):					Sc, mm/L:																									
NO. 8				89						Rc, mm/L:																									
NO. 16				73	MORTAR-MAKING PROPERTIES (CRD-C 116)																														
NO. 30				47	TYPE II CEMENT, RATIO 7 DAYS, 115 %, 28 DAYS, 116 %																														
NO. 50				21	LINEAR THERMAL EXPANSION X10 ⁻⁵ DEG. F. (CRD-C 125,126):																														
NO. 100				5	<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th>ROCK TYPE</th> <th>PARALLEL</th> <th>ACROSS</th> <th>ON</th> <th>AVERAGE</th> </tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </table>					ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE																					
ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE																															
NO. 200				1.7																															
- 200 ^(a)				1.8																															
F.M. ^(b)				2.66																															

(a) CRD-C 105 (b) CRD-C 104

MORTAR:

MORTAR-BAR EXPANSION AT 100F, % (CRD-C 123):				FINE AGGREGATE				COARSE AGGREGATE				
	3 MO.	6 MO.	9 MO.	12 MO.	3 MO.	6 MO.	9 MO.	12 MO.	3 MO.	6 MO.	9 MO.	12 MO.
LOW-ALK. CEMENT: % Na ₂ O EQUIVALENT:												
HIGH-ALK. CEMENT: % Na ₂ O EQUIVALENT:												

SOUNDNESS IN CONCRETE (CRD-C 40, 114):

	F & T	MW-CD	HD-CW
FINE AGG. Glenview Sand & COARSE AGG. Lynn Sand & Stone Co. DFE₃₀₀	57		
FINE AGG. Gravel Co. COARSE AGG. Swampscott, Mass. DFE₃₀₀			

PETROGRAPHIC DATA (CRD-C 127): **SUMMARY.** The natural sand is comprised of smooth surfaced, subrounded to angular particles of yellow to grayish green grains approximating the following percentage distribution based on the natural gradation of the processed material: 59% Quartz & Quartzite, 11% Siltstone, 10% Schist, 8% Granite, 6% Feldspar, 5% Mica, 1% Miscellaneous. Pale yellow to white, dense, hard, quartz and quartzite particles comprise 59% of the sand. Slightly weathered to weathered siltstone and schist particles comprise 21% of the sample with approximately 20% being of friable structure. The schist portion comprises of 3% phyllitic particles constitutes the weakest fraction

REMARKS: and is largely confined to the +No. 50 sieve sizes.

STATE: N.H.		INDEX NO.:		AGGREGATE DATA SHEET		TESTED BY: NED Laboratory	
LAT: 43°N		LONG: 71°W		DATE: September 1970			
LAB. SYMBOL NO.: 82-3-1 thru 4				TYPE OF MATERIAL: Proc. Sand & Gravel			
LOCATION: Route 16							
Ossipee, New Hampshire							
PRODUCER: Ossipee Aggregate Corporation							
SAMPLED BY: NED, A. Carosella							
TESTED FOR: Charles River Dam							
USED AT:							
PROCESSING BEFORE TESTING: Crushing, Sizing and Washing by Producer							
GEOLOGICAL FORMATION AND AGE: Esker - Pleistocene							

GRADING (CRD-C 103)(CUR. % PASSING):						TEST RESULTS					FINE AGG.																										
SIZE / SIEVE	1 1/2"	3/4"	1/2"		FINE AGG.		1 1/2"	3/4"	1/2"																												
6 IN.						BULK SP. GR., SAT SURF DRY (CRD-C 107,108):	2.66	2.64	2.61			2.60																									
5 IN.						Absorption, PER CENT (CRD-C 107,108):	1.02	1.35	2.06			1.32																									
4 IN.						ORGANIC IMPURITIES, FIG. NO. (CRD-C 121):	---	---	---			0+																									
3 IN.						SOFT PARTICLES, PER CENT (CRD-C 130):						---																									
2 1/2 IN.						PER CENT LIGHTER THAN SP. GR. (CRD-C 129):						---																									
2 IN.						PER CENT FLAT AND ELONGATED (CRD-C 118,120):	3.4																														
1 1/2 IN.	100	-				WEIGHTED AV. % LOSS, 5 CYC. MgSO ₄ (CRD-C 115):		2.8				7.4																									
1 IN.	74	100				ABRASION LOSS (L. A.), % (CRD-C 117):	NA	32.4																													
3/4 IN.	12	88				UNIT WT., LB/CU FT (CRD-C 106):	97.1	99.7	102.0			108.7																									
1/2 IN.	3	30	100			CLAY LUMPS, % (CRD-C 118):																															
3/8 IN.	2	8	77		100	SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124):																															
NO. 4	2	3	23		98	REACTIVITY WITH NaOH (CRD-C 128):	Sc, mm/L:																														
NO. 8	2	2	9		86		Rc, mm/L:																														
NO. 16	1	2	7		66	MORTAR-MAKING PROPERTIES (CRD-C 118)																															
NO. 30	1	2	5		38	TYPE II CEMENT, RATIO 7 DAYS 124 28 DAYS 106 %																															
NO. 50	1	2	4		15	LINEAR THERMAL EXPANSION X10 ⁻⁹ DEG. F. (CRD-C 125,126):																															
NO. 100	0.9	1.2	3.5		4	<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th>ROCK TYPE</th> <th>PARALLEL</th> <th>ACROSS</th> <th>ON</th> <th>AVERAGE</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table>							ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE																				
ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE																																	
NO. 200	0.6	0.9	2.4		1.0																																
- 200 ^(a)	0.4	0.6	1.8		1.4																																
F.M. ^(b)	7.78	6.98	5.71		2.93																																

(a) CRD-C 103 (b) CRD-C 104

MORTAR - BAR EXPANSION AT 100F, % (CRD-C 123):		FINE AGGREGATE				COARSE AGGREGATE			
		3 MO.	6 MO.	9 MO.	12 MO.	3 MO.	6 MO.	9 MO.	12 MO.
LOW-ALK. CEMENT: % Na ₂ O EQUIVALENT:									
HIGH-ALK. CEMENT: % Na ₂ O EQUIVALENT:									
SOUNDNESS IN CONCRETE (CRD-C 40, 114):						F & T HW-CD HD-CW			
FINE AGG. Ossipee Agg. Corp. COARSE AGG. Ossipee Agg. Corp.						D.F.E. 300 70			
FINE AGG. COARSE AGG:						D.F.E. 300			

PETROGRAPHIC DATA (CRD-C 127): SUMMARY: 1. Gravel. The particle constituents of the gravel fraction, based on the theoretical maximum density blend approximates the following percentages: 55% Granite, 21% Volcanics, 7% Quartzite, 4% Pegmatite, 4% Rhyolite, 3% Schist & Siltstone, 3% Diorite, 3% Miscellaneous. Angular to subrounded light tan to black, clean aggregates range from soft, weathered granites to hard dense volcanics. Approximately 59% displays varying degrees of weathering and is confined primarily to the granite, schist & siltstone fractions. No potentially deleterious rock types occurred in percentages considered critical as regards use of this aggregate in concrete. This material is of average quality and is considered to be satisfactory for the intended use.

UNIT WEIGHT, lb/cu ft for 3/4" Blend 103.7

STATE: <u>Mass.</u>		INDEX NO.:		AGGREGATE		TESTED BY: <u>ORD Laboratories</u>	
LAT: <u>42°N</u>		LONG: <u>71°W</u>		DATA SHEET		DATE: <u>February 1955</u>	
LAB. SYMBOL NO.: <u>55218</u>				TYPE OF MATERIAL: <u>Crushed Stone</u>			
LOCATION: <u>Malden, Massachusetts</u>							
PRODUCER: <u>Rowe Contracting Company</u>							
SAMPLED BY: <u>New England Division</u>							
TESTED FOR: <u>Boston Army Base</u>							
USED AT: <u>Mil. Const. Hanscom AFB, Bedford, Mass. (1954-56)</u>							
<u>Mil. Const. Boston Army Base, South Boston, Mass. (1954-56)</u>							
PROCESSING BEFORE TESTING: <u>Crushing and Sizing by Producer</u>							
GEOLOGICAL FORMATION AND AGE:							

GRADING (CRD-C 103) (CUM. % PASSING):						TEST RESULTS																								
SIZE / SIEVE					FINE AGG.				#4-3/4" FINE AGG.																					
6 IN.	2 1/2	1 1/2	3/4	1/2	3/8	BULK SP. GR., SAT SURF DRY (CRD-C 107, 108):				2.65																				
5 IN.						ABSORPTION, PER CENT (CRD-C 107, 108):				0.3																				
4 IN.						ORGANIC IMPURITIES, FIG. NO. (CRD-C 121):				---																				
3 IN.						SOFT PARTICLES, PER CENT (CRD-C 130):				---																				
2 1/2 IN.	100					PER CENT LIGHTER THAN SP. GR. (CRD-C 129):				---																				
2 IN.	97					PER CENT FLAT AND ELONGATED (CRD-C 119, 120):				---																				
1 1/2 IN.	68	100				WEIGHTED AV. % LOSS, 5 CYC. MgSO ₄ (CRD-C 115):				0.4																				
1 IN.	21	85	100			ABRASION LOSS (L. A.), %, (CRD-C 117):				16																				
3/4 IN.	5	29	97			UNIT WT., LB/CU FT (CRD-C 106):				---																				
1/2 IN.	1	2	34	100		CLAY LUMPS, % (CRD-C 118):				---																				
3/8 IN.		1	5	41	100	SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124):				---																				
NO. 4			1	2	45	REACTIVITY WITH NaOH (CRD-C 128):				Sc, mm/L: 41.6																				
NO. 8					9	Rc, mm/L:				51.3																				
NO. 16					2	MORTAR-MAKING PROPERTIES (CRD-C 116)																								
NO. 30					1	TYPE _____ CEMENT, RATIO _____ DAYS, _____ % _____ DAYS, _____ %																								
NO. 50						LINEAR THERMAL EXPANSION X 10 ⁻⁶ DEG. F. (CRD-C 125, 126):																								
NO. 100						<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th>ROCK TYPE</th> <th>PARALLEL</th> <th>ACROSS</th> <th>ON</th> <th>AVERAGE</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table>					ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE															
ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE																										
NO. 200																														
- 200 ^(a)																														
F.M. ^(b)																														

(a) CRD-C 105 (b) CRD-C 104

MORTAR:																																						
MORTAR-BAR EXPANSION AT 100F, % (CRD-C 123):																																						
<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="4">FINE AGGREGATE</th> <th colspan="4">COARSE AGGREGATE</th> </tr> <tr> <th>3 MO.</th> <th>6 MO.</th> <th>9 MO.</th> <th>12 MO.</th> <th>3 MO.</th> <th>6 MO.</th> <th>9 MO.</th> <th>12 MO.</th> </tr> </thead> <tbody> <tr> <td>LOW-ALK. CEMENT: % Na₂O EQUIVALENT:</td> <td></td><td></td><td></td><td></td> <td></td><td></td><td></td><td></td> </tr> <tr> <td>HIGH-ALK. CEMENT: % Na₂O EQUIVALENT:</td> <td></td><td></td><td></td><td></td> <td></td><td></td><td></td><td></td> </tr> </tbody> </table>					FINE AGGREGATE				COARSE AGGREGATE				3 MO.	6 MO.	9 MO.	12 MO.	3 MO.	6 MO.	9 MO.	12 MO.	LOW-ALK. CEMENT: % Na ₂ O EQUIVALENT:									HIGH-ALK. CEMENT: % Na ₂ O EQUIVALENT:								
FINE AGGREGATE				COARSE AGGREGATE																																		
3 MO.	6 MO.	9 MO.	12 MO.	3 MO.	6 MO.	9 MO.	12 MO.																															
LOW-ALK. CEMENT: % Na ₂ O EQUIVALENT:																																						
HIGH-ALK. CEMENT: % Na ₂ O EQUIVALENT:																																						
SOUNDNESS IN CONCRETE (CRD-C 40, 114):																																						
FINE AGG. <u>Weston-Bradford</u>				COARSE AGG. <u>Rowe Cont. Co.</u>																																		
FINE AGG.				COARSE AGG.																																		
				DFE ₃₀₀ <u>87</u>																																		
				DFE ₅₀₀																																		

PETROGRAPHIC DATA (CRD-C 127):
 Intermediate igneous rock
 Diorite - 65%
 Diorite with granitic inclusion - 31%
 acid igneous rock
 Granite - 4%

REMARKS:

STATE: <u>Mass</u>		INDEX NO.:		AGGREGATE		TESTED BY: <u>ORD Laboratories</u>	
LAT: <u>42°N</u>		LONG: <u>71°W</u>		DATA SHEET		DATE: <u>February 1955</u>	
LAB SYMBOL NO.: <u>55214</u>				TYPE OF MATERIAL: <u>Crushed Stone</u>			
LOCATION: <u>Quincy, Massachusetts</u>							
PRODUCER: <u>Old Colony Crushed Stone Co.</u>							
SAMPLED BY: <u>New England Division</u>							
TESTED FOR: <u>Boston Army Base</u>							
USED AT:							
PROCESSING BEFORE TESTING: <u>Crushing and Sizing by Producer</u>							
GEOLOGICAL FORMATION AND AGE:							

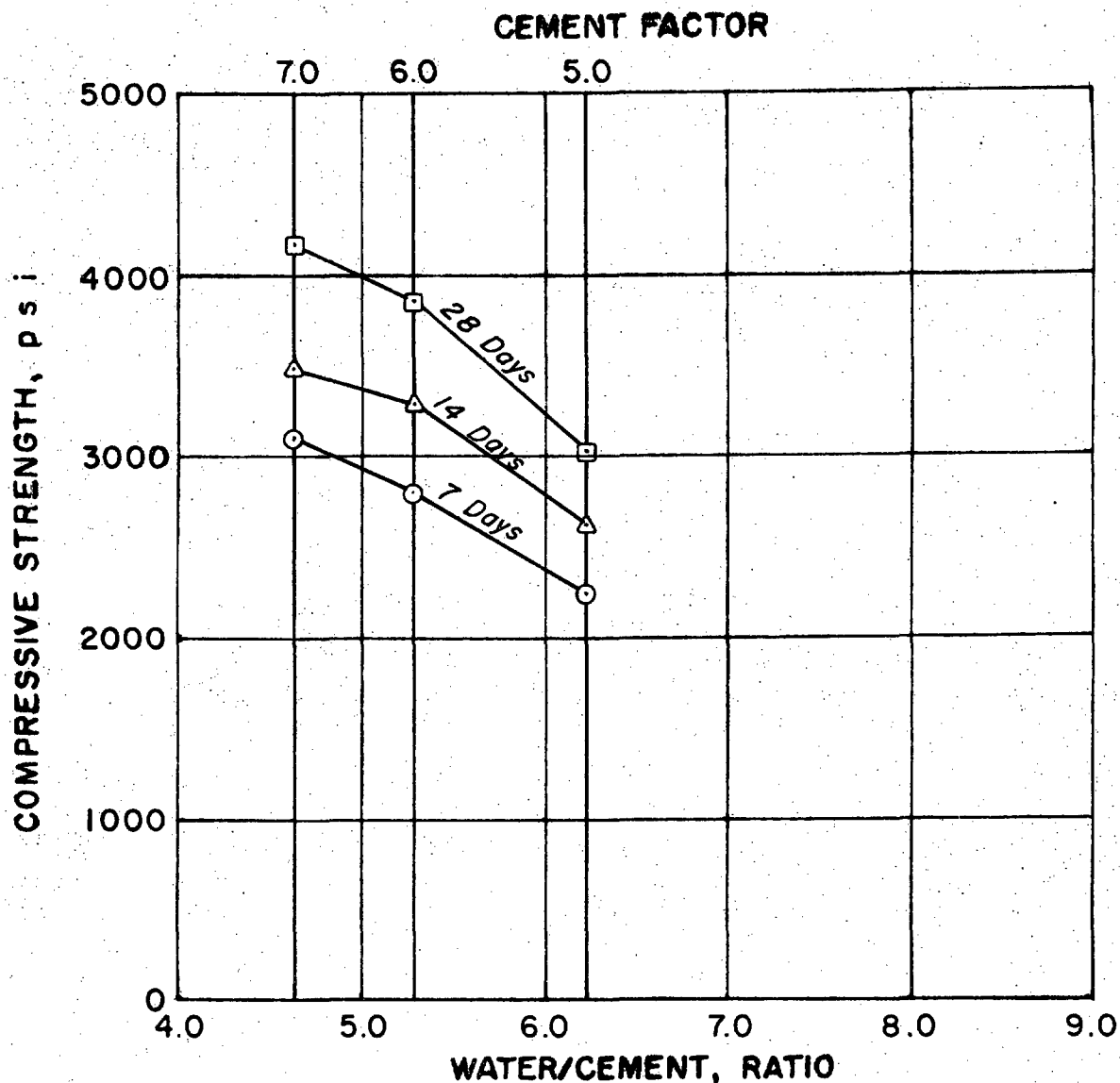
GRADING (CRD-C 103) (CUM. % PASSING):						TEST RESULTS				#4-3/4 FINE AGG.																				
SIZE / SIEVE					FINE AGG.																									
6 IN.	2"	1"	3/4"	1/2"	3/8"	BULK SP. GR., SAT SURF DRY (CRD-C 107, 108):				2.67																				
5 IN.						ABSORPTION, PER CENT (CRD-C 107, 108):				0.7																				
4 IN.						ORGANIC IMPURITIES, FIG. NO. (CRD-C 121):				---																				
3 IN.						SOFT PARTICLES, PER CENT (CRD-C 130):				---																				
2 1/2 IN.	100					PER CENT LIGHTER THAN SP. GR. (CRD-C 129):				---																				
2 IN.	99					PER CENT FLAT AND ELONGATED (CRD-C 119, 120):				11																				
1 1/2 IN.	59	100				WEIGHTED AV. % LOSS, 5 CYC. $MgSO_4$ (CRD-C 115):				1.1																				
1 IN.	3	94	100			ABRASION LOSS (L. A.), % (CRD-C 117):				34																				
3/4 IN.	1	58	98	100		UNIT WT., LB/CU FT (CRD-C 106):																								
1/2 IN.	1	5	26	94	100	CLAY LUMPS, % (CRD-C 118):																								
3/8 IN.		2	3	48	83	SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124):																								
NO. 4		1	2	10	24	REACTIVITY WITH NaOH (CRD-C 128):																								
NO. 8					20	Sc, mM/L																								
NO. 16					1	Re, mM/L																								
NO. 30						MORTAR-MAKING PROPERTIES (CRD-C 116)																								
NO. 50						TYPE _____ CEMENT, RATIO _____ DAYS, _____ DAYS, _____ DAYS																								
NO. 100						LINEAR THERMAL EXPANSION $\times 10^{-4}$ DEG. F. (CRD-C 125, 126):																								
NO. 200						<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th>ROCK TYPE</th> <th>PARALLEL</th> <th>ACROSS</th> <th>ON</th> <th>AVERAGE</th> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>2.9</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table>					ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE					2.9										
ROCK TYPE	PARALLEL	ACROSS	ON	AVERAGE																										
				2.9																										
- 200 ^(a)																														
F.M. (b)																														

(a) CRD-C 105 (b) CRD-C 104

MORTAR:					
MORTAR-BAR EXPANSION AT 100F, % (CRD-C 123):					
LOW-ALK. CEMENT:		% Na_2O EQUIVALENT:			
HIGH-ALK. CEMENT:		% Na_2O EQUIVALENT:			
SOUNDNESS IN CONCRETE (CRD-C 40, 114):					
FINE AGG. <u>Weston-Bradford</u>				COARSE AGG. <u>Old Colony</u>	
FINE AGG.				COARSE AGG.	
				DFE 500	
				DFE 300	
				F & T	
				HW-CD	
				HD-CW	

PETROGRAPHIC DATA (CRD-C 127):							
Acid igneous rock 90% Intermediate igneous rock 1%, Dark Aphanitic rock 9%							

REMARKS:							
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FINE AGGREGATE
MANCHESTER SAND AND GRAVEL
 MANCHESTER, N.H.

COARSE AGGREGATE
ROWE CONTRACTING CO.
 MALDEN, MASS.

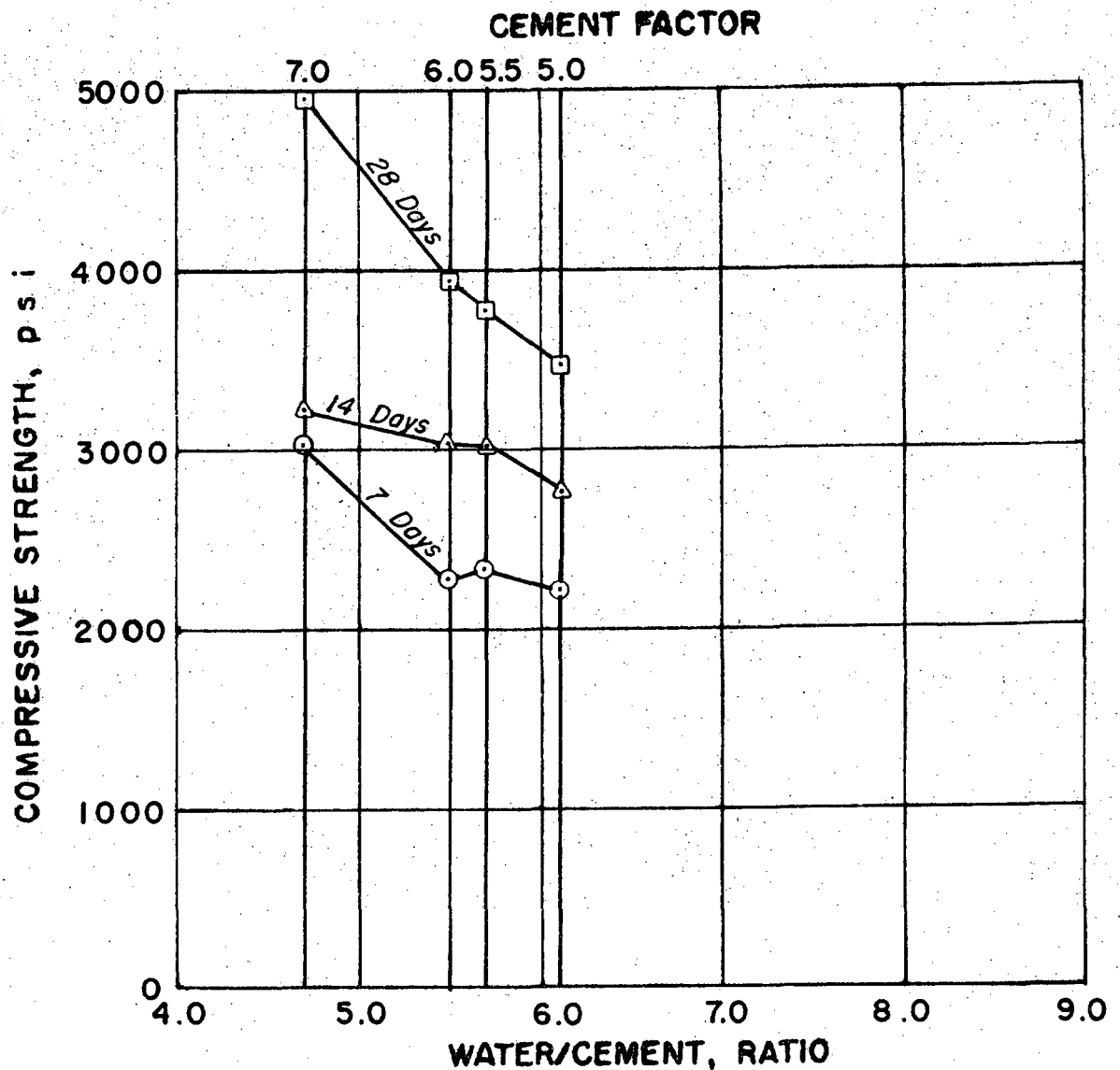
NOTE:

CONCRETE WITH 2" MAXIMUM
 SIZE COARSE AGGREGATE, 6-INCH
 SLUMP. 6.0 % ENTRAINED AIR, TYPE
 I PORTLAND CEMENT.

CHARLES RIVER DAM

CHARLES RIVER
 CONCRETE MAKING
 PROPERTIES

CHARLES RIVER, MASSACHUSETTS



FINE AGGREGATE
MANCHESTER SAND & GRAVEL CO.
 HOOKSET, N.H.

COARSE AGGREGATE
LYNN SAND & STONE CO.
 SWAMPSCOTT, MASS.

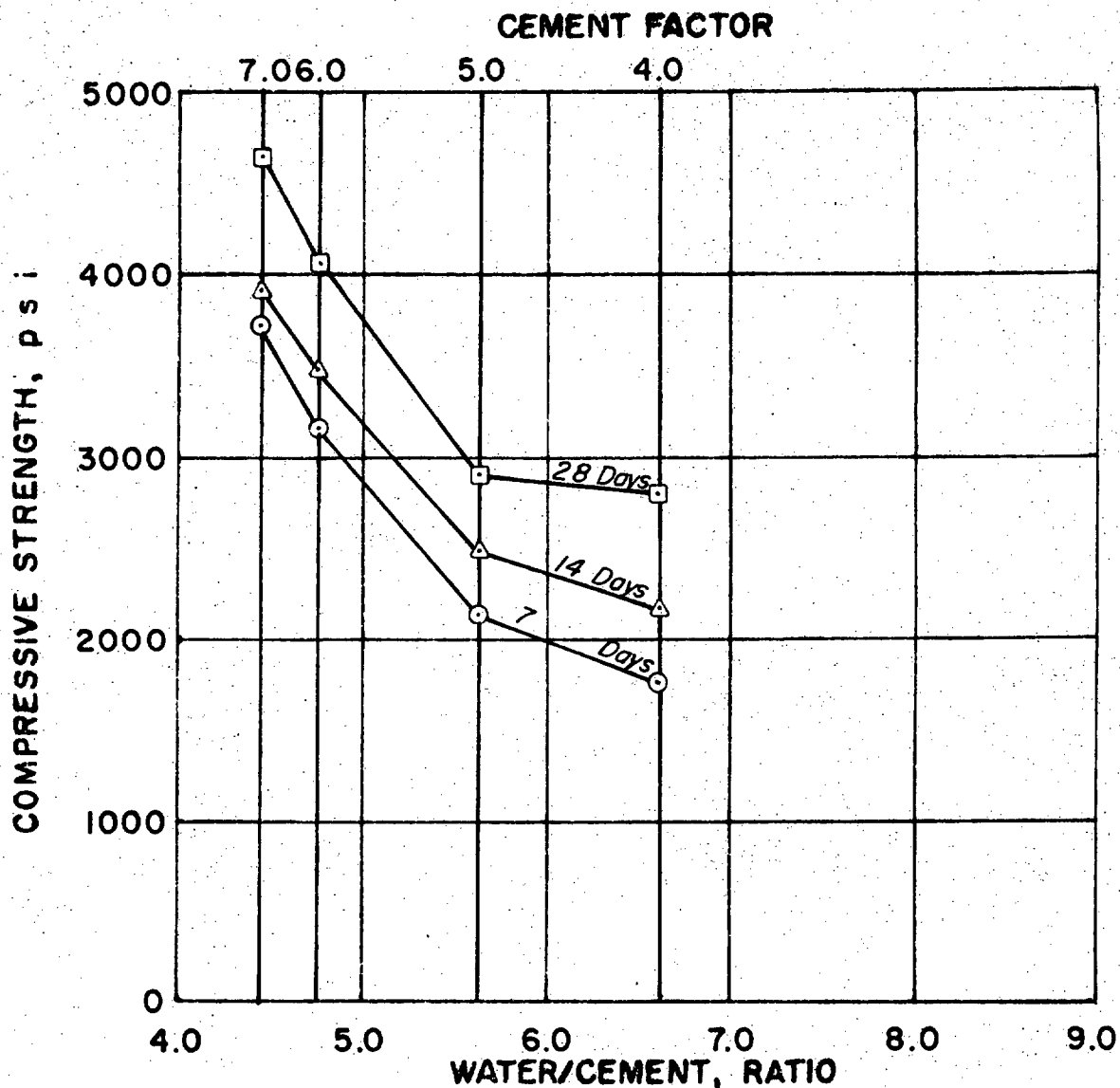
NOTE:

CONCRETE WITH 1" MAXIMUM
 SIZE COARSE AGGREGATE, 3-INCH
 SLUMP. 6.0 % ENTRAINED AIR, TYPE
 II PORTLAND CEMENT.

CHARLES RIVER DAM

CHARLES RIVER
 CONCRETE MAKING
 PROPERTIES

CHARLES RIVER, MASSACHUSETTS



PLAINVILLE SAND & STONE INC.
PLAINVILLE, MASS.

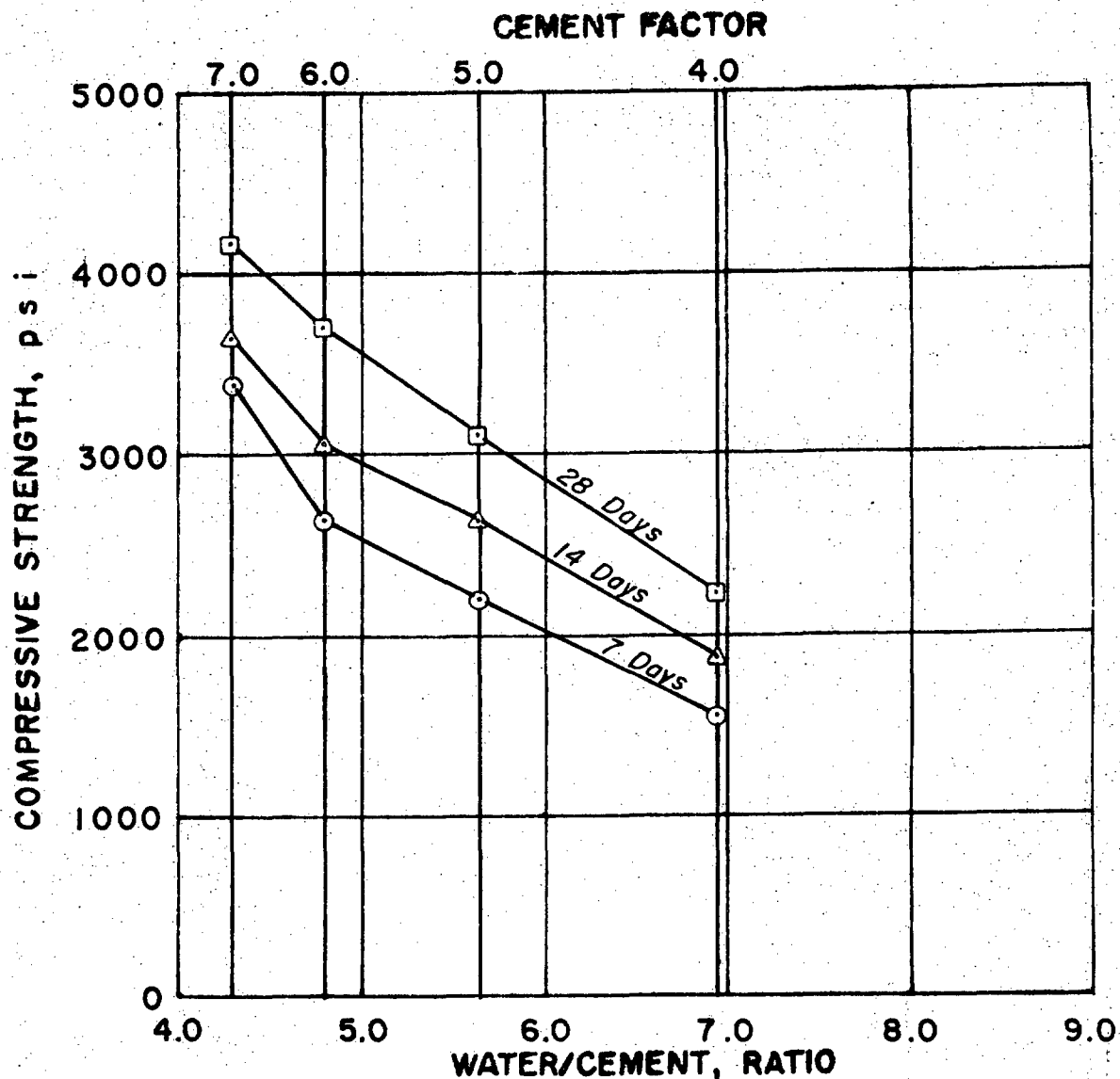
NOTE:

CONCRETE WITH 1 1/2" MAXIMUM
SIZE COARSE AGGREGATE, 3 - INCH
SLUMP. 6.0 % ENTRAINED AIR, TYPE
II PORTLAND CEMENT.

CHARLES RIVER DAM

CHARLES RIVER
CONCRETE MAKING
PROPERTIES

CHARLES RIVER, MASSACHUSETTS



OSSIPEE AGGREGATE CORP.

OSSIPEE, N.H.

NOTE:

CONCRETE WITH 1 1/2" MAXIMUM
SIZE COARSE AGGREGATE, 3-INCH
SLUMP. 6.0% ENTRAINED AIR, TYPE
II PORTLAND CEMENT.

CHARLES RIVER DAM

CHARLES RIVER
CONCRETE MAKING
PROPERTIES

CHARLES RIVER, MASSACHUSETTS

PLATE 3-14